DOCUMENT RESUME

ED 199 685 CS 005 980

AUTHOR Juel, Connie; Holmes, Betty
TITLE Testing a Hierarchical Model of Word Identification.
PUB DATE Apr 81
NOTE 29p.; Paper presented at the Annual Meeting of the American Educational Research Association (Los Angeles, CA, April 13-17, 1981).

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Cognitive Processes; College Students; *Context Clues; Decoding (Reading); Elementary Education; Grade 2; Grade 5; Higher Education; *Models; Phoneme Grapheme Correspondence; *Reading Processes; *Reading Research; *Redundancy; Word Frequency; *Word Recognition
IDENTIFIERS *Orthographic Redundancy

ABSTRACT

A study was conducted into the operation of an interactive-compensatory model of reading. Specifically, it examined the development of context-free word recognition skills, their role in contextual reading, and the degree to which one word recognition skill might compensate another. Four word factors were examined: (1) orthographic redundancy (the total number of occurrences of specific letter combinations in specific word positions), (2) versatility (in how many different words specific letter combinations occur per position), (3) decodability (predictability of letter-sound correspondences), and (4) word frequency. Subjects were 12 good and 12 poor second and fifth grade readers and 24 college students. Each subject saw a word and two pictures displayed on a screen and decided which picture illustrated the meaning of the word. Effects of context on the word identification process were examined by comparing reaction times when words were presented with no context and with either average or rich sententially constraining context. Results indicated that with increasing age, readers became more sensitive to letter combinations that appear in particular positions in a number of different words, a factor that appears to play an important role in word identification. It also appeared that even highly constrained context did not significantly diminish the processing of word parts. (Author/FL)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED199685

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Testing a Hierarchical Model of Word Identification

Connie Juel

Betty Holmes

The University of Texas at Austin

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Connie Juel

Betty Holmes

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

AERA, 1981

CS005980

Interactive models of reading (Rumelhart, 1977; Morton, 1969) are gaining acceptance as the most accurate available descriptions of the reading process. Recently, Stanovich (1980) has refined the role of interaction in such models by suggesting that it frequently occurs in a compensatory fashion. Good and poor readers are most clearly differentiated by thier word recognition skills; whereas more skilled readers can efficiently decode words, less skilled readers must compensate for their poor decoding abilities by relying on context to achieve word identification. Indeed there is much evidence indicating that mastery of rapid context-free word identification is one of the major factors that separates good from poor readers (Biemiller, 1977-78; Lesgold & Perfetti, 1978; Liberman & Shankweiler, 1979; Pace & Golinkoff, 1976; Perfetti & Lesgold, 1977; Perfetti, 1977; Perfetti & Hogaboam, 1975; Shankweiler & Liberman, 1972). Presumably both groups of readers use context to some extent for word identification, depending on both the salience of internal word cues (e.g., frequency, orthographic structure) and the degree of contextual constraint. However, poor readers are more dependent on context to augment information obtained through their relatively deficient decoding processes. The purpose of the current investigation was to gain insight into the operation of an interactive-compensatory model. Specifically, we were interested in the development of context-free word recognition skills, their role in contextual reading, and the degree to which one word recognition skill may compensate for another.

The most readily available and useful cue for context-free word recognition is the string of letters that comprise a word. Although it

is possible that certain highly frequent words are recognized as graphemic gestalts, it is more likely that identification is normally mediated by recognition of individual letter patterns. Indeed, in their review of the word recognition literature, Venezky and Massaro (1979) conclude that, "Words are not recognized as holistic units; letter analysis and the use of orthographic structure must mediate their recognition" (p. 104). Although the exact nature of this mediation remains unclear, at least three factors have been identified which seem promising. The first of these factors is orthographic redundancy. Specifically, readers have been shown to be sensitive to letter-positional frequencies (the number of occurrences of specific letters in specific word positions and word lengths) (Mason, 1975); Massaro, Venezky, & Taylor, 1979; Massaro & Taylor, 1979; Juel & Solso, 1980a). Recently there is evidence that readers are more sensitive to letter combinations that appear in a large number of different words than to letter combinations that appear with equal frequency, but in a few number of different words (Juel & Solso, 1980b). This factor has been termed versatility, and with the help of high speed computers it has been possible to accurately describe words both in terms of their positional versatility (i.e., ones in which letter combinations appear in numerous other words in the same positions) as well as pure letter combination frequencies (the total frequency of occurrence of letter combinations by positions) (Solso & Juel, 1980). Finally, there is evide[illegible] that letter-sound correspondences or phonic structures are used in the word identification process (Calfee, Venezky, & Chapman, 1969; Shankweiler & Liberman, 1972; Juel, 1980).

In the current study we examined the influence of these three factors, as well as word frequency, on the word identification processing of good

and poor second and fifth grade readers, and adults. Word recognition latencies for words that varied orthogonally on all four dimensions were compared when the words were read in isolation to when they were read with either average or highly constrained rich context. We were specifically interested in the degree to which orthographic redundancy, versatility, and decodability (letter-sound correspondences) influence speed of word recognition both with and without context, and the degree to which readers of different ages and abilities are influenced by these characteristics.

Method

Subjects

A total of 24 children and 24 adults participated in the study. The children were enrolled in a summer reading program at The University of Texas at Austin, and the adults were upper-division undergraduate education students. The children were randomly selected from a larger group of incoming second and fifth graders who scored between 88 and 126 on an abbreviated form of the Wechsler Intelligence Scale for Children-Revised (WISC-R), until six good and six poor second grade readers and six good and six poor fifth grade readers were obtained. (Mean IQ scores for both the good and poor readers was 102). Good readers were those who scored six months to two years above their grade placement on both the word recognition and passage comprehension subtests of the Woodcock Reading Battery. Poor readers scored six months to two years below their grade placement on the same measures.

Material

Sixty-four four-letter words were selected which varied factorially on all possible combinations of the experimental word factors (high/low

versatility; high/low orthographic redundancy; easy/hard decodability, high/low word frequency). Versatility and orthographic redundancy measures were based on the summed positional bigram versatility (SOBIV's) and frequency (SOBIF's) norms of Solso and Juel (1980). The mean summed versatility for high versatile words was 87 per million, with a range from 64 to 145. The mean summed versatility for low versatile words was 49 per million, with a range from 9 to 55. The mean summed frequency for orthographically redundant words was 9202, with a range from 5695 to 17157. The mean summed frequency for nonredundant words was 2216, with a range from 90 to 5185. Easy decodable words had vowel and consonant sound patterns which corresponded both to their major sounds correspondences as cited in Venezky (1970) and represented commonly taught phonic generalizations (e.g., $C\bar{V}CE$, $C\breve{V}C$, $\bar{V}V$). Hard decodable words had either vowel or consonant patterns that corresponded to the minor sound patterns of Venezky and/or represented exceptions to common phonic generalizations. Frequency was determined by the total word frequency count of Carroll, Davies, and Richman (1971). The mean frequency for high frequency words was 1183 per about five million, with a range from 123 to 5386. The mean frequency for low frequency words was 41 per about five million, with a range from 2 to 88.

Word recognition latencies for all 64 words were tested in a condition of no context. The subjects saw a slide with a word and two pictures displayed on a screen. One picture depicted the meaning of the word and one did not. The subject pressed a reaction time button corresponding to the correct picture. The equivalency of difficulty in deciphering the pictures was controlled. Twelve adults, who were not subjects in the experiment, were shown each slide with the two pictures, but with the target word covered.

The experimenter orally named the target word while these subjects pressed the corresponding RT button. Mean scores for high and low frequency words were computed. Only picture pairs which had RT's within one standard deviation of the appropriate mean were used. All words appeared in black, lower case print, while the pictures were black schematic drawings.

For the context condition the 64 words were divided into two balanced sets representing the 4 word factors. In one set a slide containing a sentence with average contextual cues as to the identity of the target word preceded the target word and pictures slide. In the other set a slide containing a sentence with highly constraining, rich context preceded the target word and pictures slide. In both contexts the nontarget word picture would fit the sentence (e.g., for, "Sit under the shade of the _____," the two pictures were of a tree and an umbrella). The only difference, then, between the context conditions and the isolation condition, was the additional slide preceding the target word and picture slide. Sample materials are shown in Table 1.

Insert Table 1 about here

The context levels were established through a modified cloze procedure. Twenty adults read potential sentences with blanks inserted for the target words. They were asked to fill in the blanks. Average context sentences were those in which the target word was mentioned by not more than 10% of the subjects. (Such sentences are labeled "average" context as adult readers appear to be able to use context to predict no more than one in ten context words in running text (Gough, Alford, & Holley-Wilcox, 1978.) Rich context sentences were those in which the target word was mentioned by at least 75% of the subjects.

Apparatus

Visual stimuli were displayed on a back projected screen by means of a carousel projector. Each display was shown by means of a remote control switch which simultaneously initiated a 1/100 second time. A reaction time device was made which consisted of two keys mounted on a wooden board each of which when depressed stopped the 1/100 second timer.

Procedure

Subjects were tested individually in two sessions at least one week apart. The order of the two conditions--isolation or context--was selected randomly. Subjects sat in front of a table with one hand resting on the RT keyboard. For the isolation condition, the subjects were instructed to read the word silently, select the picture which best represented the meaning, and press the RT key which corresponded to the appropriate picture. For the context condition the subjects were given the following instructions: 1) read the sentence with the missing word; 2) press a RT key to indicate the completion of reading; 3) read the word on the screen; 4) choose the picture which represents the meaning; and 5) press the RT key corresponding to the picture. On pressing the RT key to indicate completion of sentence reading the slide containing the target word automatically appeared on the screen in approximately 950 msec. This time interval allows for conscious facilitative effects of context (Stanovich & West, 1979). Children were instructed to ask for help if they could not read any of the words in the sentences, but were told they would not receive help on the words which filled the blanks. In practice, help was rarely needed as we had made an effort to use relatively easy and common words in the sentences. Practice slides were presented with both conditions until the subject's responses

were automatic. The sequence of slides in both conditions was reordered periodically to offset any order effects.

Design

The 64 target words for the isolation condition were developed from a fully crossed 2^4 factorial design. The four word factors were: word frequency (high, low), orghographic redundancy (high, low), versatility (high, low), and decodability (easy, hard). There were four replications of each word type (i.e., four easy decodable, high frequency, high orthographically redundant, high versatile words). When the two levels of context (average, rich) were added to this design the result was a completely crossed 2^5 factorial.

When the subjects were children, both the isolation and context conditions employed a mixed design in which variables were factorially combined. The between subjects factors were grade (2, 5) and reading ability (good, poor). The within subjects factors were decodability, word frequency, orthographic redundancy, versatility, and context (in the context condition), as described above. With adult subjects in both conditions the within subjects design was the same, but there were no between subjects factors.

Results and Discussion

The data were analyzed by repeated measures analysis of variance for a multi-factor design--along the lines of Winer, 1971, p. 558. In order to ascertain the effects of each factor on reading words in isolation and in context, analyses were performed separately on the two conditions. Only correct responses were analyzed. The error rate was approximately nine percent for children and four percent for adults. A significance level of .05 was adopted. Analyses were performed on both the raw data with outliers

removed (scores in excess of three standard deviations) and on medians. Both analyses yielded consistent results. Analysis of the raw data appears in this report. Significant main effects and means appear in Tables 2 and 3. Additionally, R^2's were computed in order to describe the proportion of variance accounted for in each condition by the independent factors. Means in the tables represent RT's from the instant the target word display appeared on the screen until the key press. It was decided to limit interpretations to main effects and two way interactions as higher order interactions were based on a relatively small number of exemplar word types. Further, no higher order interaction accounted for more than .001 percent of the variance. All significant two way interactions are discussed in the text.

Insert Tables 2 and 3 about here

Children

As shown in Table 2, both Grade and Ability had significant main effects on RT's in both conditions and accounted for substantial proportions of the vairance. In particular, ability accounted for 43% of the total variance in reading words in isolation. It is again clear that rapid context-free word recognition is a major factor that distinguishes good from poor readers.

In the isolation condition there were significant main effects of Frequency, Versatility, Decodability, and Orthographic Redundancy (Table 2). The first three factors had the largest impact on RT's. There was an interaction of Grade and Frequency ($F=12.7$, $p < .01$) indicating that Grade 2 readers are disproportionately slowed by low frequency words. Younger

readers may be slower both visually recognizing low frequency words and/or accessing their meanings. There were two particularly significant interactions, each accounting for almost one percent of the variance: Grade by Versatility, $F=40.1$, $p<.01$ and Grade by Decodability, $F=20.9$. $p<.01$ (Figure 1). It appears that Grade 2 readers are relatively insensitive to versatility (i.e., to bigrams that commonly occur in particular positions in words) and rely heavily on letter-sound correspondences (decodability) to identify words. While Grade 5 readers also appear to use letter-sound relationships, they appear very influenced by versatility. Apparently, exposure to large numbers of words--which is more likely to have occurred in Grade 5--is necessary to develop sensitivity to letter combinations that frequently occur in many different words. It is clear, however, that when such knowledge develops, it greatly speeds word processing. It also appears that words with low versatile letter combinations that also have difficult letter-sound correspondences (Versatility X Decodability, $F=12.7$, $p<.01$), and low frequency words with difficult letter-sound patterns (Frequency X Decodability, $F=16.1$, $p<.01$), are especially hard to identify (Figures 2 and 3).

Insert Figures 1, 2, and 3 about here

In the context condition the significant main effects for word factors were Context, Frequency, Versatility, Decodability, and Orthographic Redundancy. However, only Frequency and Decodability accounted for much variance (Table 2). When reading with context, Grade 5 readers appear to rely primarily on "sounding out" words (Figure 4). That is, when reading a versatile word such as "pear" in isolation, such readers may find a direct

match from its component letter combinations (e.g., "pe," "ea," "ar"), in their respective positions, to the word, but in context the apparent emphasis on sound decoding slows its recognition as the "ea" does not have a common sound correspondence. Presumably these readers attempt to achieve sound correspondences prior to lexical access. Neither the Versatility by Grade nor the Versatility by Decodability (Figure 2) interactions reached significance with context, due to the lesser overall impact of versatility. The Frequency by Decodability interaction, however, was still significant in context ($F=5.9$, $p<.05$; Figure 3).

Insert Figure 4 about here

While the main effect of context accounted for less than one percent of the variance, it did interact significantly with Decodability ($F=9.0$, $p<.01$), Frequency ($F=9.3$, $p<.01$), and Orthographic Redundancy ($F=7.2$, $p<.05$) (Figure 5). With rich context, low frequency words are much more quickly identified than in average context. Presumably the rich context especially speeds lexical access of infrequent words either because readers can now consciously predict these words (e.g., Bees live in a _____; That isn't a frog, it's a _____.) or such rich context automatically activates the memory location of the low frequency words (e.g., bees--hive; frog--toad) (Posner & Snyder, 1975; Stanovich & West, 1979). However, such facilitation still appears mediated by graphic information. Hard decodable words are not helped by context as much as easy decodable words. On-going decoding processes are apparently aided, but not replaced, by contextual information. Overall, the orthographic redundancy effect replicates our previous findings that nonredundant words are more quickly recognized than highly

redundant ones (Juel & Solso, 1980a; Juel & Solso, 1980b). Highly redundant words are comprised of letter combinations that are often similar to those in a small number of highly frequent words. Thus, they are prone to confusion with other words unless they are either carefully analyzed or are embedded in highly constrained context--as in the rich context sentences.

Insert Figure 5 about here

Adults

As shown in Table 3, there is a very similar pattern of results in the isolation and context conditions. In both conditions there are significant main effects of Frequency, Versatility, and Decodability. Orthographic redundancy is significant only in the isolation condition. With the addition of context, highly redundant words are less confusable. Context is significant, but accounts for only about four percent of the variance. There was a significant interaction between Context and Decodability ($F=14.9$, $p<.01$; Figure 6). We again see that context can facilitate decoding, but does not appear to replace it. Even with rich context, hard decodable words are more slowly processed than easy ones. Adults appear to use letter-sound correspondences to some extent in reading. There were no other interactions of context with any factor. Even rich context does not appear to diminish the efforts of processing component word parts.

Insert Figure 6 about here

Versatility accounted for almost ten percent of the variance in the context condition. The trend seen in children continued to grow. Versatility

also interacted significantly with Frequency and Decodability (Context: Versatility X Frequency, $F=19.5$, $p<.01$; Versatility X Decodability, $F=6.4$, $p<.05$) (Isolation: Versatility X Frequency, $F=12.0$, $p<.01$; Versatility X Decodability, $F=31.5$, $p<.01$) (Figures 7 and 8). Low versatile, low frequency and low versatile, hard decodable words are especially slow to be identified. That is, words that contain letter combinations which do not appear in many different words and are also either unlikely to be "sight" words (i.e., low frequency words) or have difficult letter-sound patterns (i.e., hard decodable words) slow the reader.

Insert Figures 7 and 8 about here

Conclusions

With increasing age, readers become more sensitive to letter combinations that appear in particular positions in a number of different words (Versatility). This factor appears to play a very important role in word identification. Its impact appears much more powerful than that of simple orthographic redundancy (total occurrences of letter combinations). It may be that readers frequently identify words by mapping their component letters onto letter combination "templates." When words contain highly versatile letter combinations, such as "ea" in the second and third position of a four-letter word, such processing is expedited. However, such direct visual processing appears to often be complimented by processing to sounds (e.g., "ea" → "ē"). It further appears that even highly constrained context does not significantly diminish the processing of component word parts.

References

Biemiller, A. Relationship between oral reading rate for letters, words, and simple text in the development of reading achievement. Reading Research Quarterly, 1977-78, 13, 2, 223-253.

Calfee, R. C., Venezky, R. L., & Chapman, R. S. Pronunciation of synthetic words with predictable and unpredictable letter-sound correspondences (Tech. Rep. 71) Madison: Wisconsin Research and Development Center for Cognitive Learning, 1969.

Carroll, J. B., Davies, P., & Richman, B. American heritage: A word frequency book. Boston: Houghton-Mifflin, 1971.

Juel, C. L. Comparison of word identification strategies with varying context, word type, and reader skill. Reading Research Quarterly, XV, No. 3, 1980, 358-376.

Juel, C. L. & Solso, R. L. Effects of Orthographic and Phonic Structures on Word Identification. In M. L. Kamil and A. J. Moe (Eds.), Perspectives in Reading Research and Instruction, 29th Yearbook of the National Reading Conference. Washington, D. C.: The National Reading Conference, 1980.

Lesgold, A. M. and Perfetti, C. A. Interactive processes in reading comprehension. Discourse Processes, 1978, 1, 323-336.

Liberman, I. Y & Shankweiler, D. Speech, the alphabet, and teaching to read. In L. B. Resnick and P. Weaver (Eds.), Theory and practice of early reading. Hillsdale, N. J.: Lawrence Erlbaum and Assoc., 1979.

Mason, M. Reading ability and letter search time: Effects of orthographic structure defined by single-letter positional frequency. Journal of Experimental Psychology: General, 1975, 104, 146-166.

Massaro, D. W. & Taylor, G. A. Reading ability and the utilization of orthographic structure in reading. Technical Report No. 515. Wisconsin Research and Development Center for Individualized Schooling, July, 1979.

Massaro, D. W., Venezky, R. L., & Taylor, G. A. Orthographic regularity, positional frequency, and visual processing of letter strings. Journal of Experimental Psychology: General, 1979, 108, 197-224.

Morton, J. Interaction of information in word recognition. Psychological Review, 1969, 76 (2), 165-178.

Pace, A. J. & Golinkoff, R. M. Relationship between word difficulty and access of single word meaning by skilled and less skilled readers. Journal of Educational Psychology, 1976, 68, 760-767.

Perfetti, C. A. Language comprehension and fast decoding: Some psycholinguistic prerequisites for skilled reading comprehension. In J. Guthrie (Ed.), Cognition, Curriculum and Comprehension. Newark, Delaware: International Reading Association, 1977.

Perfetti, C. & Hogaboam. The relationship between single word decoding and reading comprehension skill. Journal of Educational Psychology, August, 1975, 67, 461-469.

Perfetti, C. A. & Resgold, A. M. Discourse comprehension and sources of individual differences. In M. Just & P. Carpenter (Eds.), Cognitive Processes in Comprehension. Hillsdale, N.J.: Lawrence Erlbaum Assoc., 1977.

Posner, M. I. & Snyder, C. R. R. Attention and cognitive control. In R. L. Solso (Ed.), Information processing and cognition: The Loyola Symposium. Hillsdale, N. J.: Lawrence Erlbaum Assoc., 1975.

Rumelhart, D. E. Toward an interactive model of reading. In S. Dornic (Ed.), Attention and Performance (Vol.VI). Hillsdale, N.J.: Lawrence Erlbaum Assoc., 1977.

Shankweiler, D. & Liberman, I. Y. Misreading: A search for causes. In J. F. Kavanaugh and I. G. Mattingly (Eds.), Language by Ear and by Eye. Cambridge, Mass.: The MIT Press, 1972.

Solso, R. L., & Juel, C. L. Positional frequency and versatility of bigrams for two- through nine-letter English words. Behavior Research Methods and Instrumentation, 1980, 12, 297-343.

Stanovich, K. E. Toward an interactive-compensatory model of individual differences in the development of reading fluency, Reading Research Quarterly, 1980, 14, 1, 32-71.

Stanovich, K. E. & West, R. F. Mechanisms of sentence context effects in reading: Automatic activation and conscious attention. Memory and Cognition, 1979, 4 (2), 77-85.

Venezky, R. L. The structure of English orthography. The Hague: Mouton, 1970.

Venezky, R. L. & Massaro. D. W. The role of orthographic regularity in word recognition. In L. B. Resnick and P. A. Weaver (Eds.), Theory and Practice of Early Reading, Vol. 1, Hillsdale, N. J.: Lawrence Erlbaum Assoc., 1979.

Winer, B. J. Statistical principles in experimental design (2nd ed.). New York: McGraw-Hill Book Company, 1971.

Reference Notes

Gough, P. B., Alford, J. A. Jr., & Holley-Wilcox, P. Words and contexts. Paper presented at the National Reading Conference, St. Petersburg, Florida, 1978.

Juel, C. L. & Solso, R. L. The role of orthographic redundancy, versatility, and spelling-sound correspondences in word identification. Paper presented at the National Reading Conference, San Diego, CA, 1980.

Table 1

Sample Materials

Target Word	Target Word Characteristics	Context
hair	high frequency, versatile, redundant, hard decodable	The girl has long _____. (rich)
hive	low frequency, nonversatile, redundant, easy decodable	Bees live in a _____. (rich)
rain	high frequency, versatile, nonredundant, easy decodable	The street was wet from _____. (rich)
tree	high frequency, nonversatile, nonredundant, easy decodable	Sit under the shade of the _____. (rich)
toad	low frequency, versatile, nonredundant, easy decodable	That isn't a frog, it's a _____. (rich)
crib	low frequency, nonversatile, nonredundant, easy decodable	The baby sleeps in a _____. (rich)
cove	low frequency, versatile, redundant, easy decodable	The boat was in the _____. (average)
gate	high frequency, versatile, nonredundant, easy decodable	Open the _____. (average)
shoe	high frequency, nonversatile, nonredundant, hard decodable	She needs a _____. (average)
lamp	high frequency, versatile, nonredundant, easy decodable	Don't hit the _____. (average)
pear	low frequency, versatile, nonredundant, hard decodable	Eat the _____. (average)
spit	low frequency, nonversatile, nonredundant, easy decodable	The child likes to _____. (average)

Table 2

Means[1], Analysis of Variance, and R^2's for all Main Effects for Children

	Context				Isolation			
Source	F	Error	Means	R^2	F	Error	Means	R^2
Grade	41.8**	17.596		.252	50.8**	10.414		.212
2			3443				3000	
5			2058				1827	
Reading Ability	33.0**	17.596		.199	103.3**	10.414		.430
Poor			3366				3250	
Good			2136				1577	
Context	13.7**	1.907		.009				
Average			2882					
Rich			2620					
Word Frequency	110.0**	2.450		.092	114.4**	.238		.043
Low			3054				2677	
High			2448				2151	
Versatility	5.6*	1.042		.002	47.3**	.510		.010
Low			2813				2539	
High			2689				2288	
Decodability	87.0**	2.000		.060	94.0**	.923		.035
Hard			2912				2652	
Easy			2590				2176	
Orthographic Redundancy	8.1**	.685		.002	9.5**	.867		.003
Low			2691				2340	
High			2811				2487	

---

* $F(1,20) = 4.35$, $p < .05$

** $F(1,20) = 8.10$, $p < .01$

1 milliseconds

Table 3

Means[1], Analysis of Variance, and R^2's for all Main Effects for Adults

	Context				Isolation			
Source	F	Error	Means	R^2	F	Error	Means	R^2
Context	54.6**	.0502		.044				
Average			1045					
Rich			961					
Word Frequency	60.7**	.1088		.106	12.0**	.1976		.074
Low			1068				1140	
High			937				1061	
Versatility	41.6**	.1463		.098	36.9**	.0615		.069
Low			1066				1139	
High			940				1062	
Decodability	23.5**	.1096		.042	32.6**	.0377		.037
Hard			1054				1133	
Easy			952				1068	
Orthographic Redundancy	.0	.1094		.000	10.3**	.0561		.018
Low			1001				1081	
High			1005				1120	

---

* $F(1,23) = 4.28$, p .05

** $F(1,23) = 7.88$, p .01

[1] milliseconds

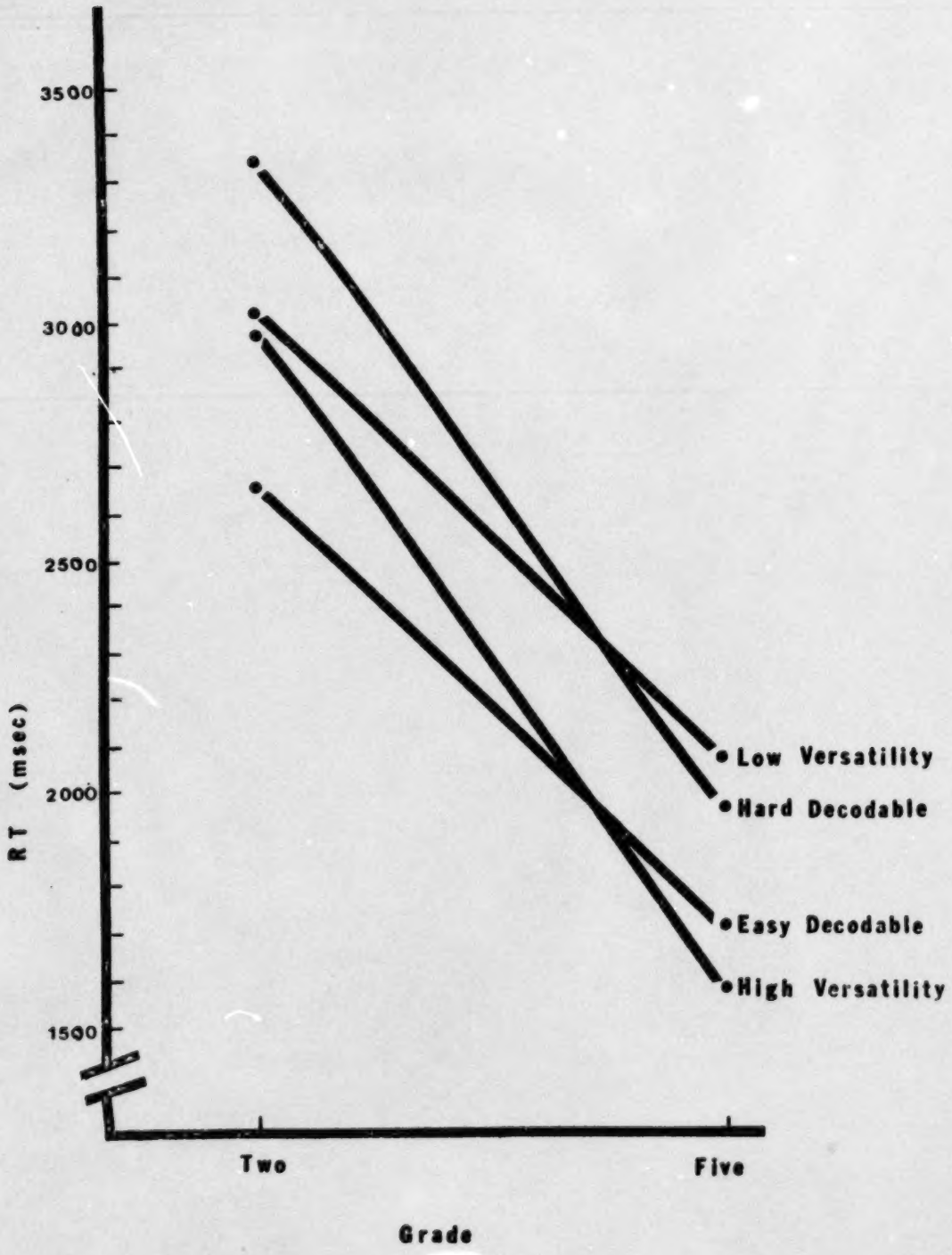
3500
3000
2500
2000
1500
RT (msec)
Low Versatility
Hard Decodable
Easy Decodable
High Versatility
Two
Five
Grade

Figure 1

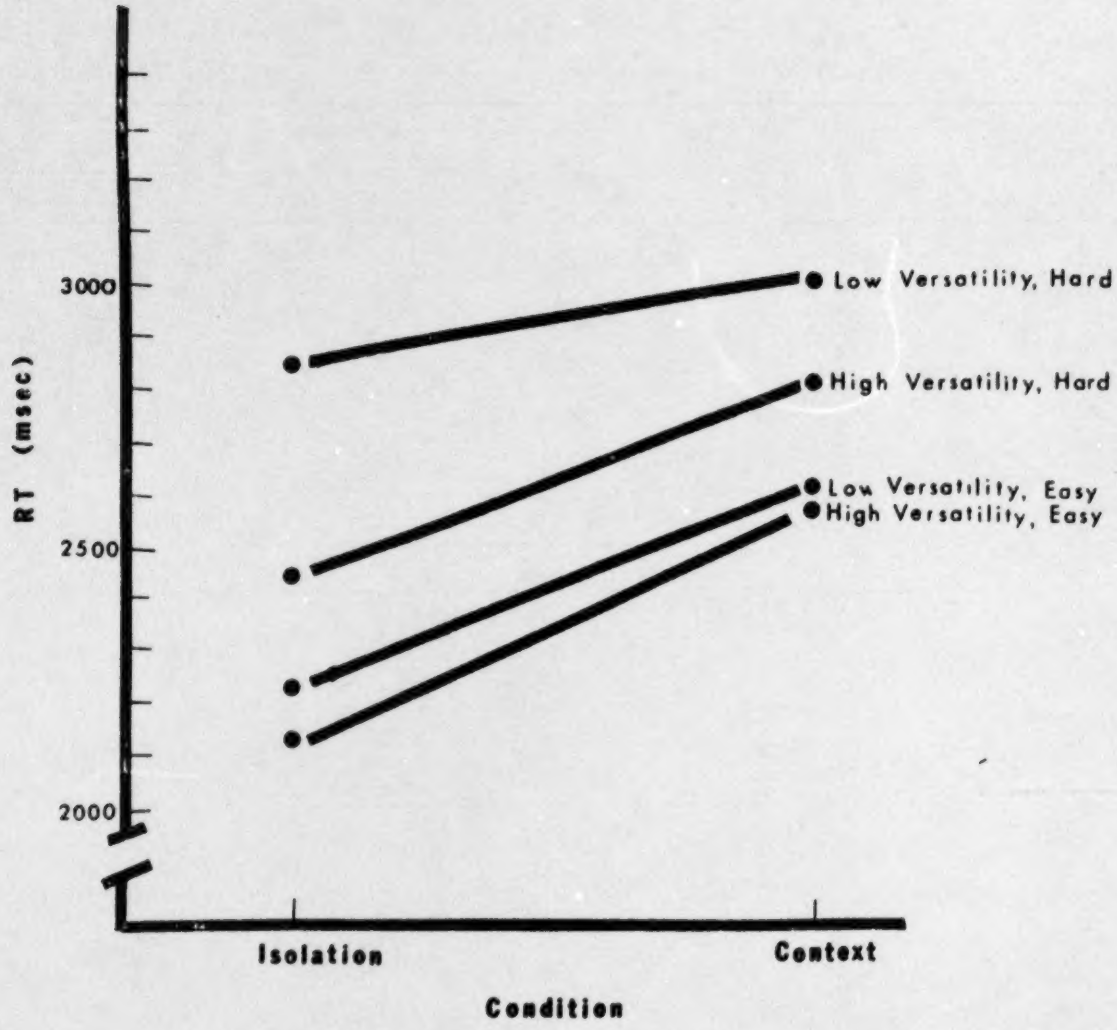
3000
2500
2000
RT (msec)
Low Versatility, Hard
High Versatility, Hard
Low Versatility, Easy
High Versatility, Easy
Isolation
Context
Condition

Figure 2

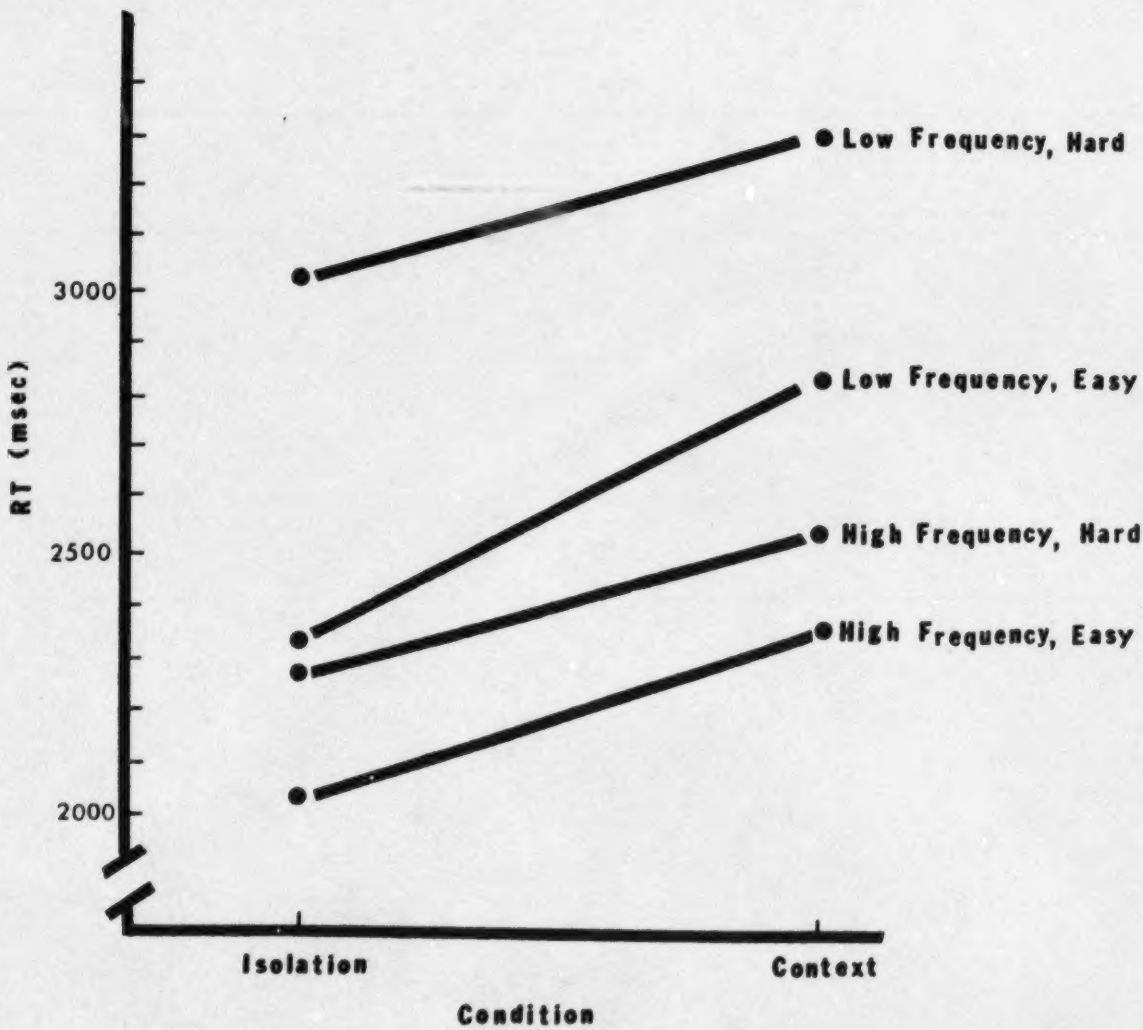
Low Frequency, Hard
Low Frequency, Easy
High Frequency, Hard
High Frequency, Easy
RT (msec)
3000
2500
2000
Isolation
Context
Condition

Figure 3

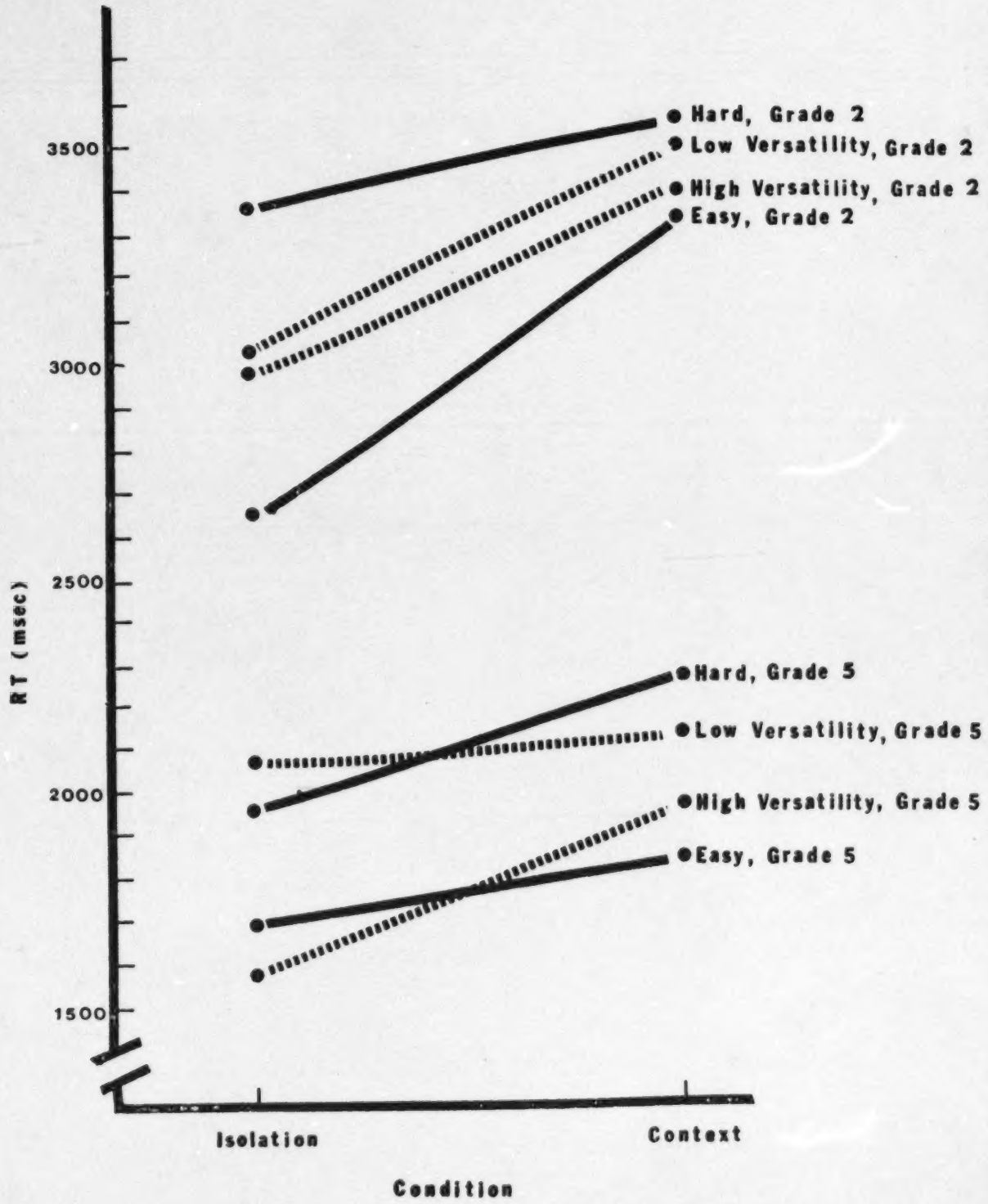
3500
3000
2500
2000
1500
RT (msec)
Hard, Grade 2
Low Versatility, Grade 2
High Versatility, Grade 2
Easy, Grade 2
Hard, Grade 5
Low Versatility, Grade 5
High Versatility, Grade 5
Easy, Grade 5
Isolation
Context
Condition

Figure 4

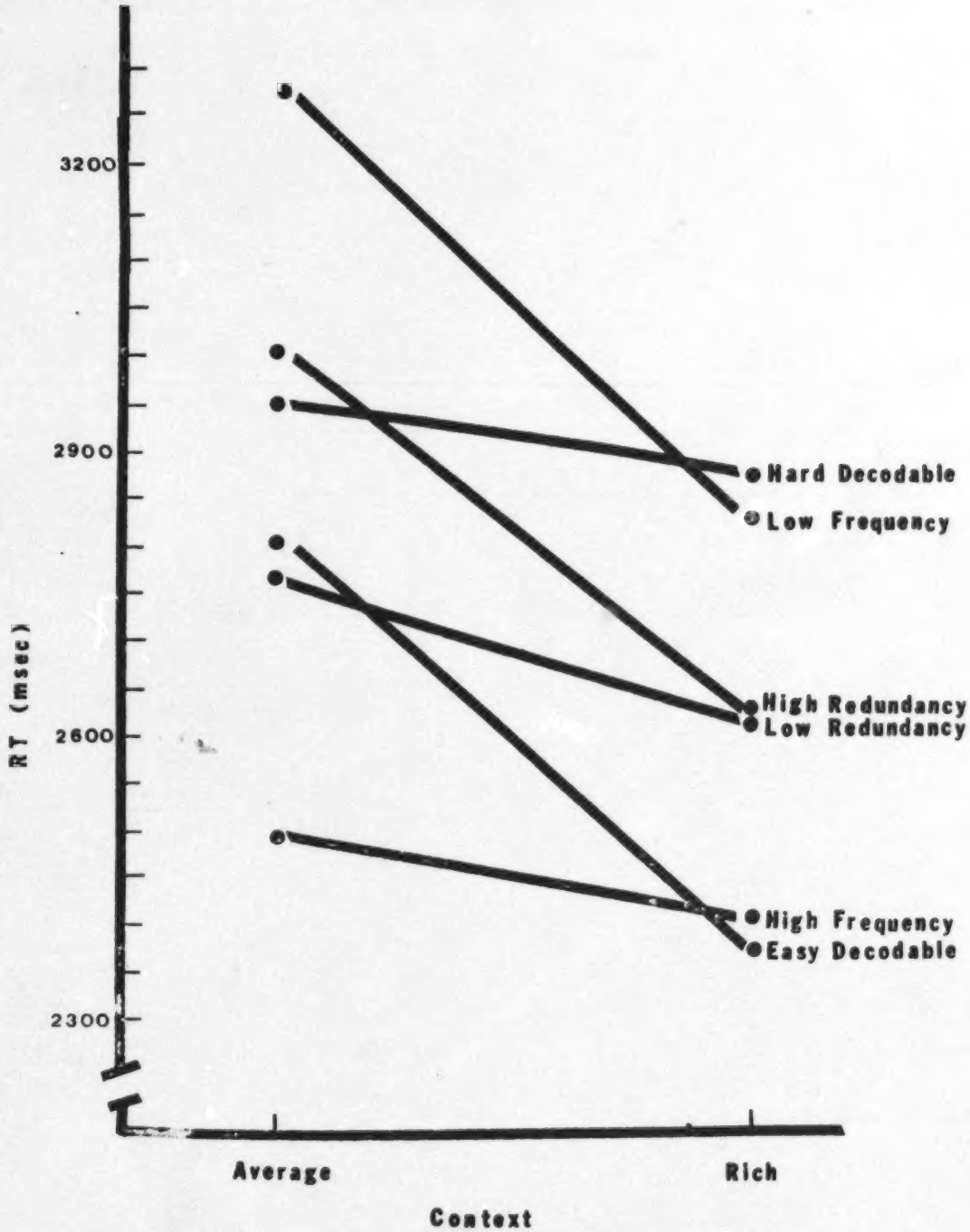
3200
2900
2600
2300
RT (msec)
Hard Decodable
Low Frequency
High Redundancy
Low Redundancy
High Frequency
Easy Decodable
Average
Rich
Context

Figure 5

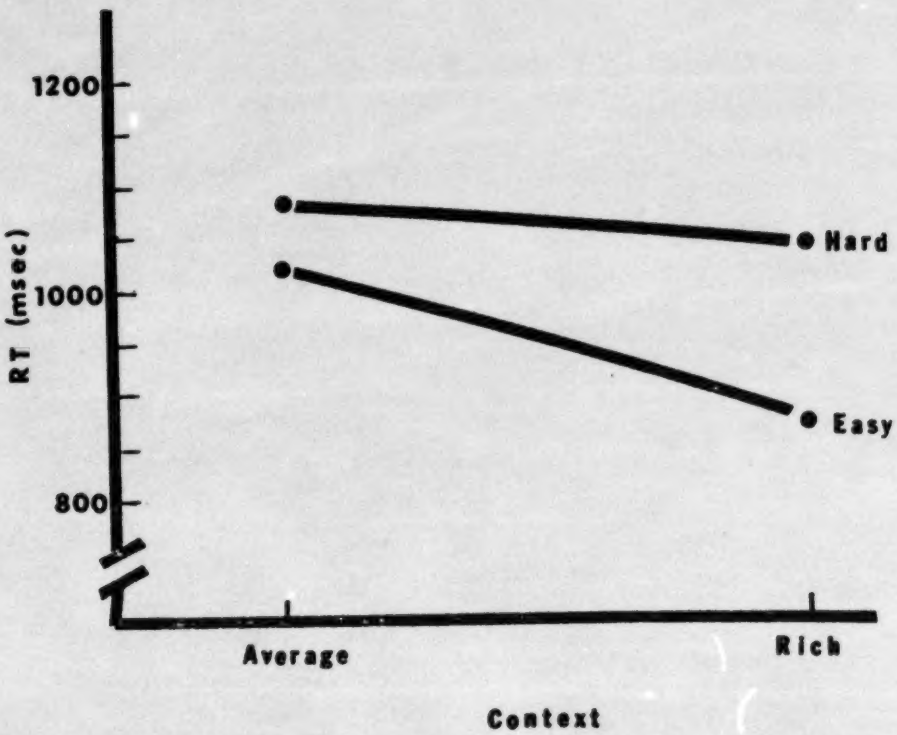

Figure 6

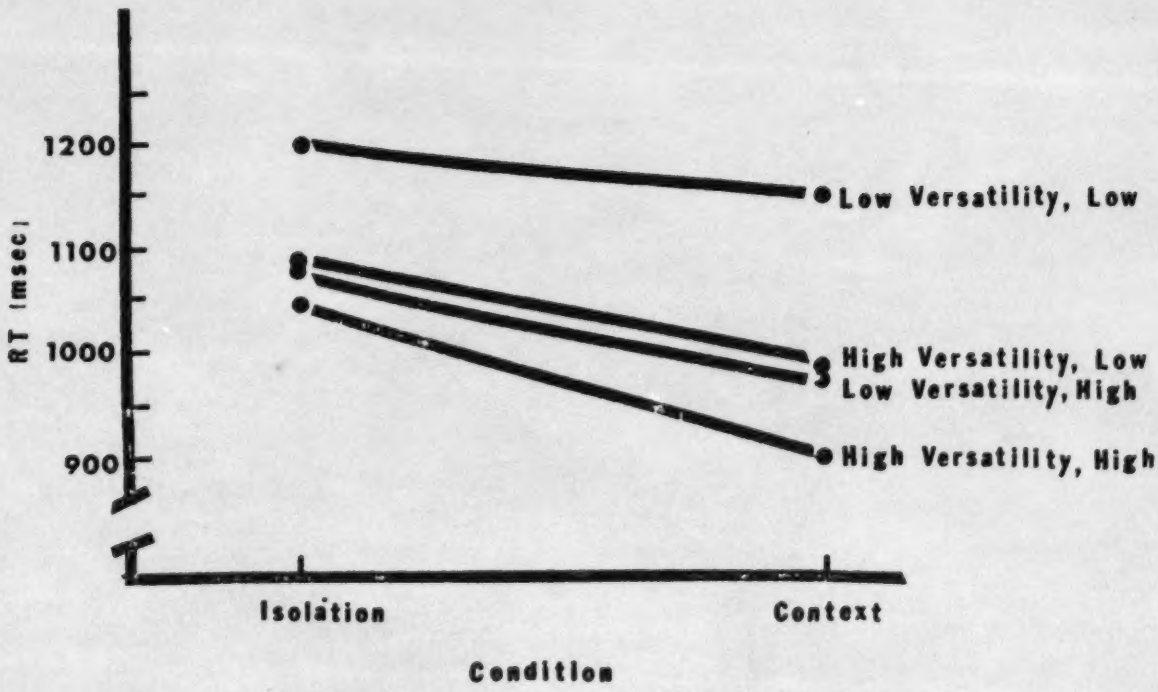
1200
1100
1000
900
RT (msec)
Low Versatility, Low
High Versatility, Low
Low Versatility, High
High Versatility, High
Isolation
Context
Condition

Figure 7

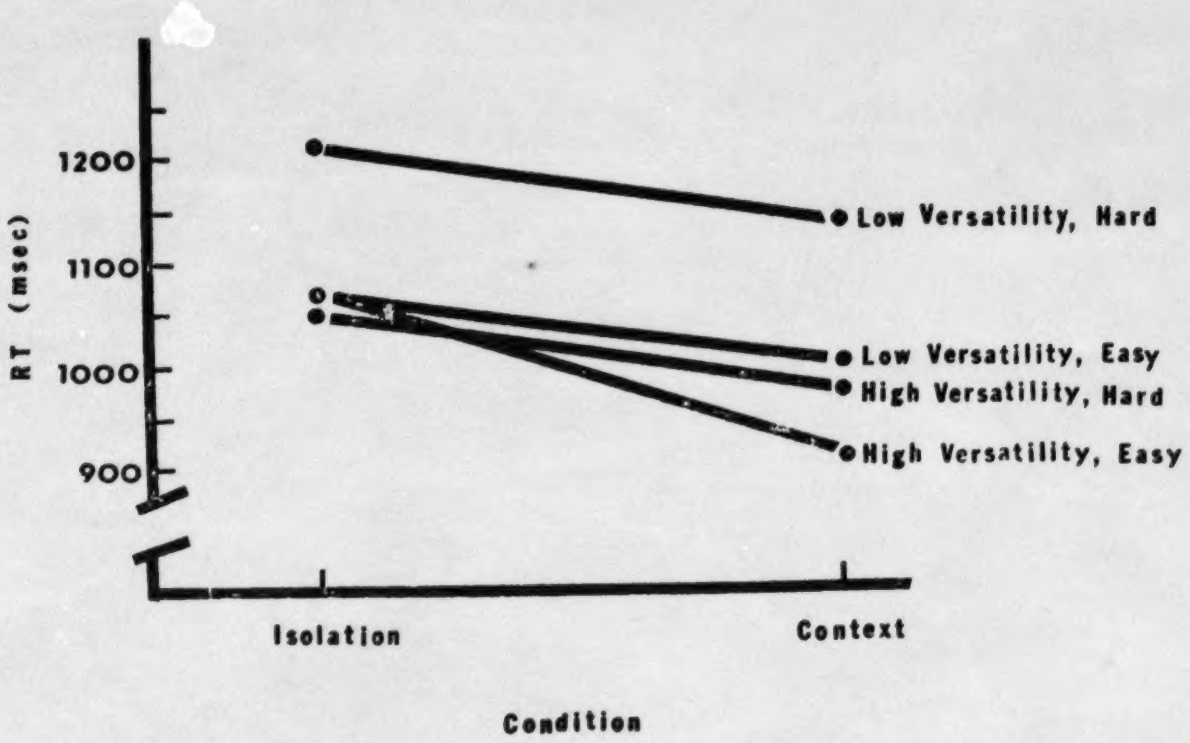
1200
1100
1000
900
RT (msec)
Low Versatility, Hard
Low Versatility, Easy
High Versatility, Hard
High Versatility, Easy
Isolation
Context
Condition

Figure 8